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STAT

20 March 1964
LEGtls-126

COPY

Chief, Office of Naval Research
Department of the Navy
Washington 25, D. C.

Attention: Code 414, STAT

Subject: Contract STAT Application of Perceptron Concepts to Photo-Interpretation

Enclosure: Nine Copies of Letter Report No. 25

Dear Sir:

We are enclosing nine copies of Letter Report No. 25 covering our technical progress under Contract STAT during February 1964.

Of the contract estimated cost as amended by Modification #6 amounting to STAT we have expended STAT as of 1 March 1964, STAT leaving a balance of STAT In terms of cumulative labor and indirect costs under the contract, the following is a summary as of 1 March 1964:

STAT

DDR-DUPE

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Approved For Release 2006/07/07 : CIA-RDP78B04770A002300030037-5

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[redacted] STAT

Letter Report No. 25

Investigation of Perceptron Applicability to Photo Interpretation

[redacted] STAT

Monthly Letter Report
for the month of February 1964

[redacted] STAT

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Approved For Release 2006/07/07 : CIA-RDP78B04770A002300030037-5

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[redacted] Report No. 23 STAT

Letter Report No. 25

Investigation of Perceptron Applicability to Photo Interpretation

Monthly Letter Report

for the month of February 1964

1.0 INTRODUCTION

Project PICS is an investigation of the applicability of perceptrons to automation of certain parts of the photo interpretation task. Particular emphasis is placed on area and object recognition based upon properties derived from two-dimensional power spectra. Accordingly, effort is centered in the following major areas:

1) Theoretical and experimental evaluation of the properties which can be derived by optical spatial filtering.

2) Design and implementation of a recognition system based upon such properties.

3) Design of optical-electronic spatial filtering equipment.

4) Research based upon ideas whose immediate applicability cannot be stated, but of potential long-term benefit.

2.0 ACTIVITY AND ACCOMPLISHMENTS DURING FEBRUARY 1964

2.1 Property Evaluation

No work on spectral property evaluation was done during February.

2.2 Design of Optical-Electronic Spatial Filtering Apparatus

Basic experiments on a spatial filtering apparatus using a laser light source were described in last month's report. Appendix A of this report contains photographs taken at the time of these experiments but not prepared for printing early enough for inclusion with the January discussion. Captions with each set of photographs are self-explanatory.

Approved For Release 2006/07/07 : CIA-RDP78B04770A002300030037-5

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The newly-designed experimental apparatus mentioned last month was essentially completed during February, and has been named the "Mark III Spatial Filter Recognition Apparatus". Figure 1 is a diagrammatic layout of the Mark III. The unique features of this system are (1) the original scene is scanned (mechanically in this case) and the two-dimensional power spectrum computed (optically) for an elemental area in the original scene and (2) categorization would depend upon logical combination of the power spectrum determinations. No definitive experiments have been performed as of the end of the reporting period, but preliminary trials indicate that:

a) the optical system is adequate

b) there is sufficient sensitivity

c) the distinctive frequency-plane signature of straight lines in the object plane is observable and automatically detectable.

The basic application of this apparatus is culture detection by measurement of straight line density. It is also a proving ground machine for other spectral properties expected of having utility for photo-interpretation.

2.3 Recognition Studies

Synthetically generated patterns which have been previously used for recognition studies were used in a new set of experiments to obtain the effects of the additional distortions produced by the isolation and standardization processes. These additional distortions are produced because the figures are often torn into several pieces by the noise generation process.

A 500 A-unit perceptron was trained to recognize all aircraft in a large sample of these patterns. A different set of 866 patterns was used to test its performance. There were 42 classification errors (4.8%) in this experiment. This is to be compared with no errors in a set of 720 patterns in previous experiments which did not use isolation and standardization.

Upon examination of the types of errors which were made, it seemed possible that inclusion of a scale-factor objective property would lower the error rate. An experiment showed that this was a false hope. Hindsight indicates that the patterns which were not aircraft were both smaller and larger than the aircraft, and thus a scale factor property could not aid linear separability.

Approved For Release 2006/07/07 : CIA-RDP78B04770A002300030037-5

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3.0 PLANS FOR MARCH 1964

Experiments in culture detection on the Mark III apparatus using synthetic and real photo segments will be attempted. This should provide the first significant test of spatial-filter-derived properties as recognition clues.

Some studies of perceptron training using only prototypes will be carried out.

4.0 REPORTS

No reports other than the regular monthly letter report were due or issued during February.

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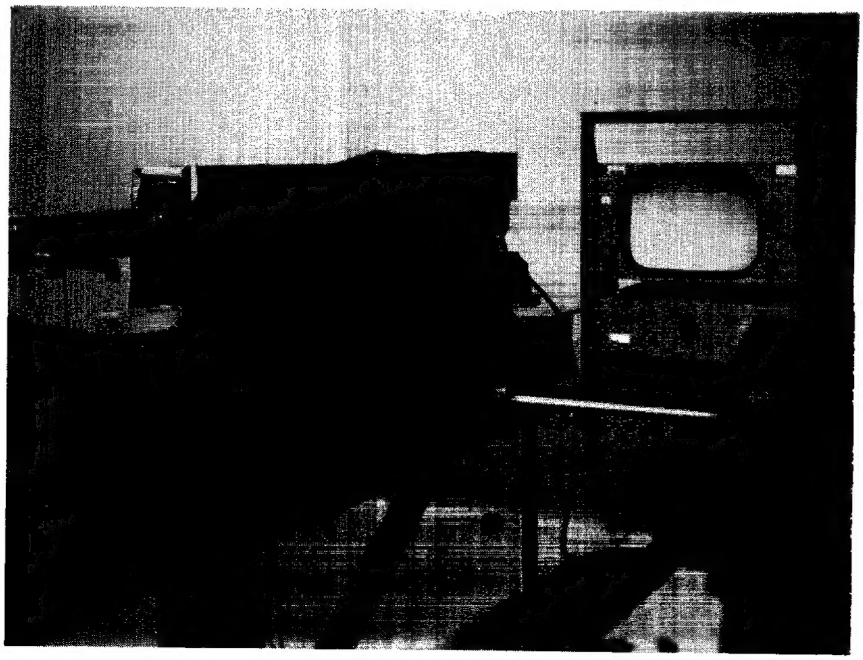

Experimental Set-up

The optical chain includes:

- [redacted] Model 115 gas laser (6328 Å) Hemispherical mode, 1.0 mw CW, diffraction limited, uniphase, spherical wavefront, beam diameter 3 mm. STAT
- Object film or pinhole
- Lens
- Occluding filter
- Lens
- Vidicon and Monitor (Kintel) or film

Contents

For these five objects: a pinhole, railroad yard, parking lot, field, and brush land; a 3 mm diameter laser beam illuminated a part of the object film.

Each page following contains (1) the spatial frequency plane photograph, (2) the monitor display of this plane, and (3) the video voltage signal for given lines of the monitor display.

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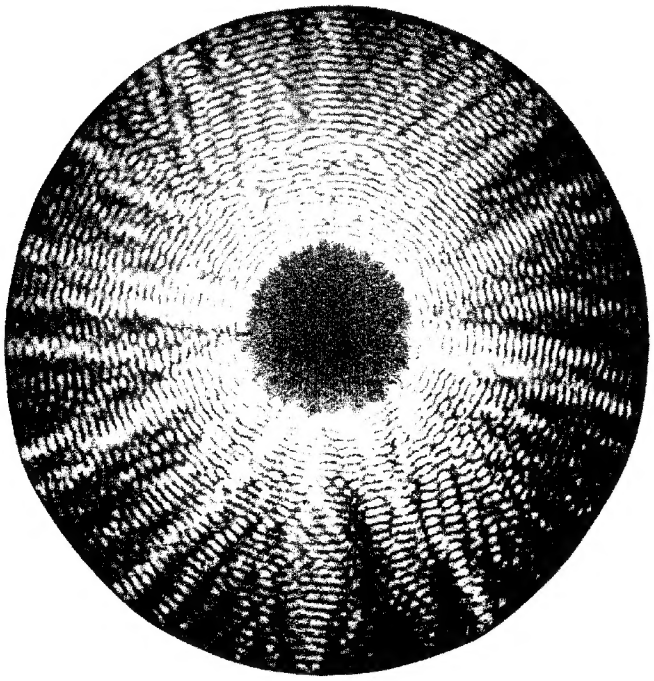

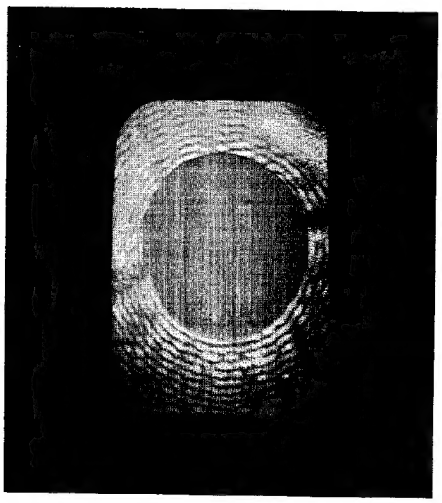

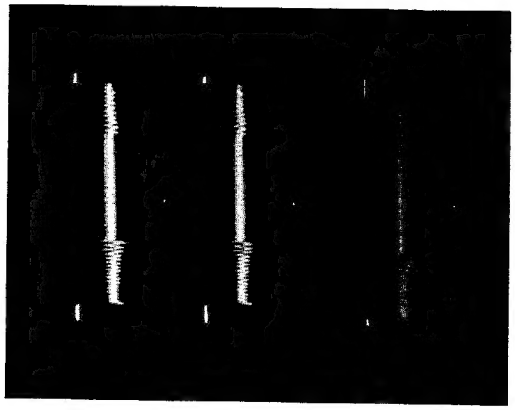

Airy rings of 1 mm pinhole

Bandpass occluding filter used in this case has central stop disc of 10.8 mm diameter and surrounding stop inside diameter of 35.5 mm; the passband is 12.6 cycles/mm to 46 cycles/mm.

All video signals shown are same center line of the raster taken at different exposures.

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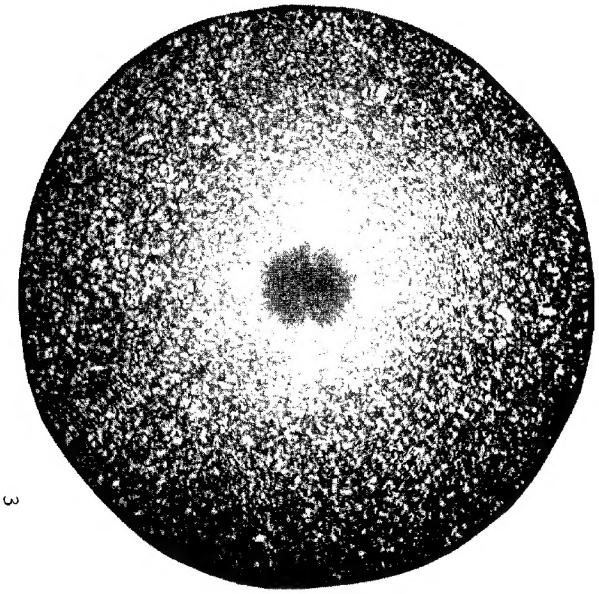

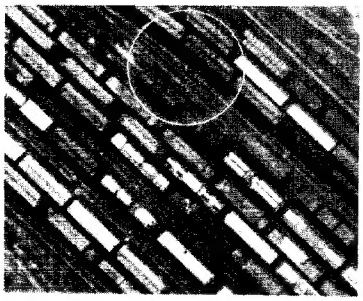

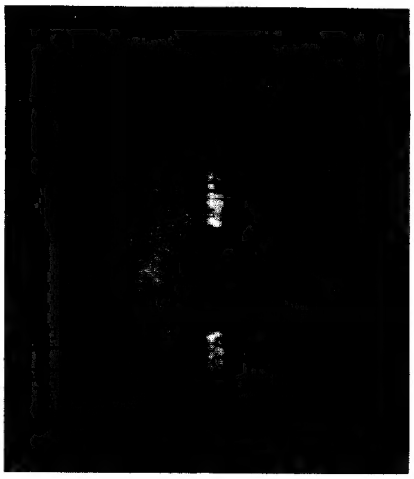

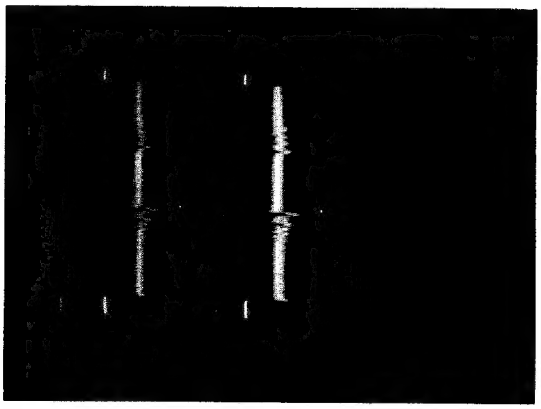

Rail yard objective film

Bandpass occluding filter used here (and in all the following examples) has a central stop disc of 5.8 mm diameter and a surrounding stop inside diameter of 37 mm; the passband is 7.3 cycles/mm to 47 cycles/mm.

The video signals correspond to the raster center line.

Approved For Release 2006/07/07 : CIA-RDP78B04770A002300030037-5

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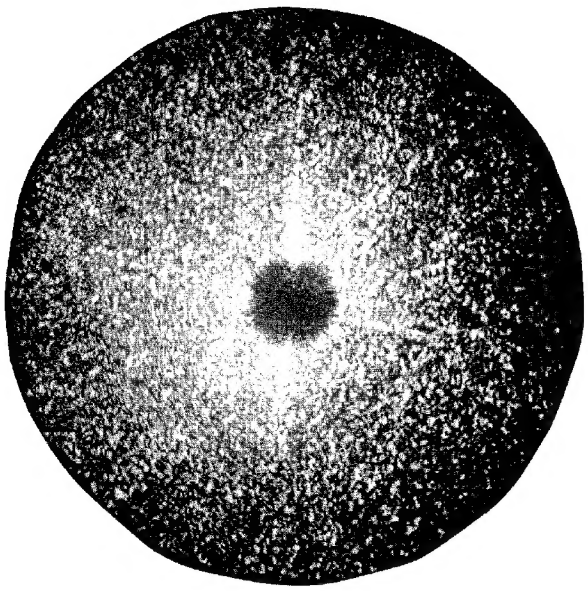

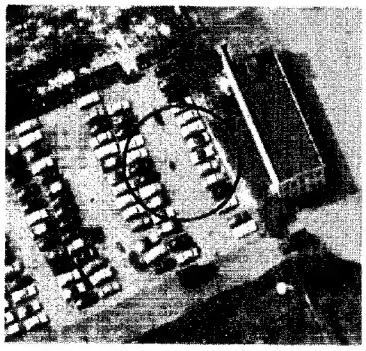

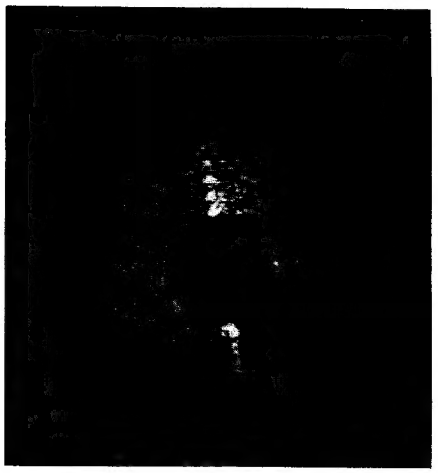

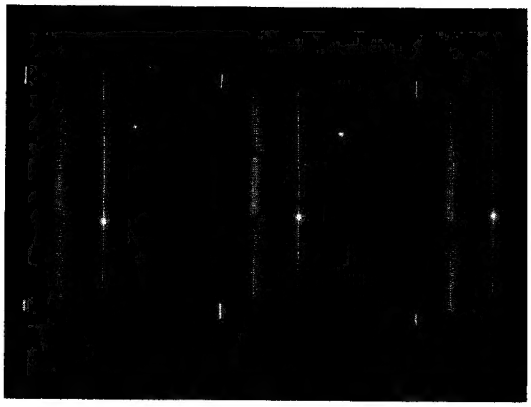

Parking lot objective film

The video signals are for three different horizontal lines near the raster center: about 25 TV lines below center, center line, and about 25 TV lines above center from print top-to-bottom.

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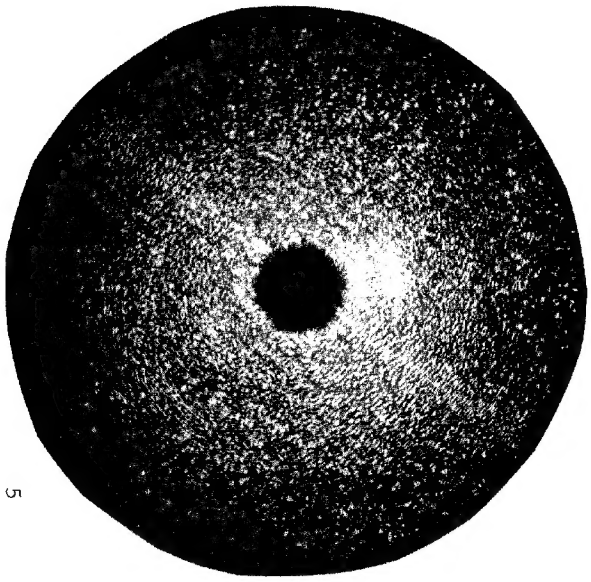

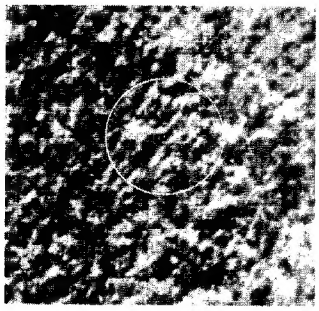

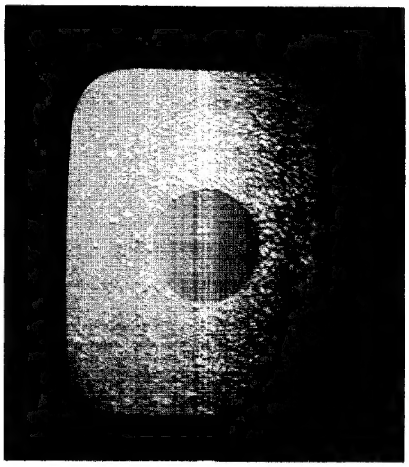

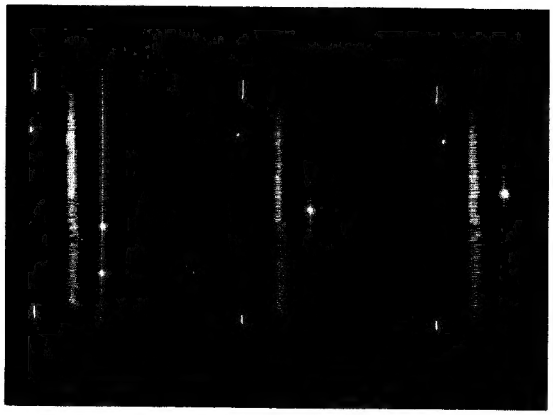

Field objective film

The video lines are, top to bottom, (1) through bottom one-quarter of occluding disc, (2) through center line, and (3) (unplanned) double exposure.

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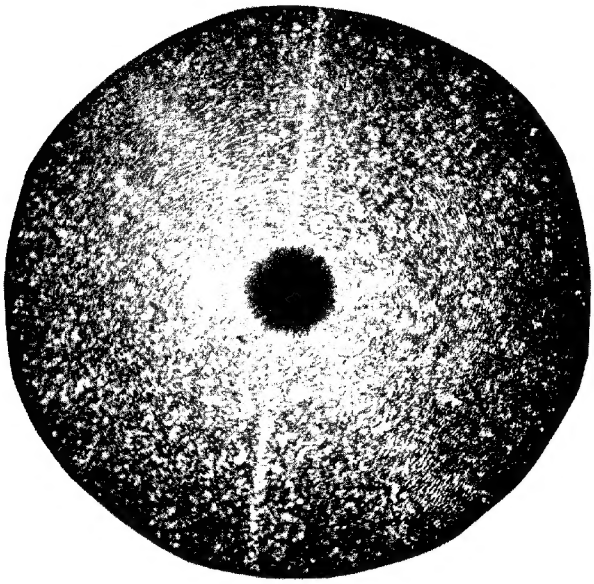

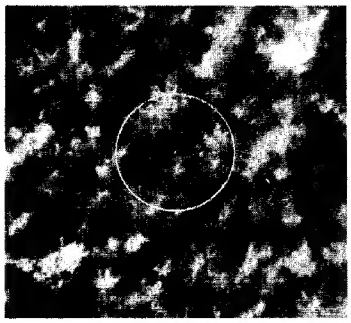

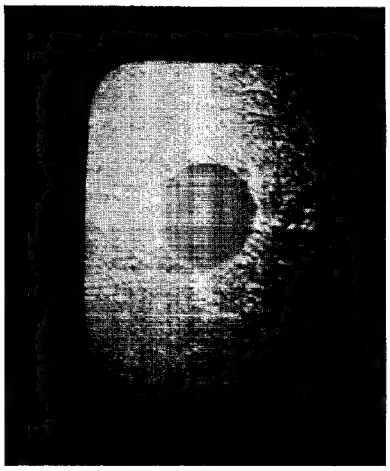

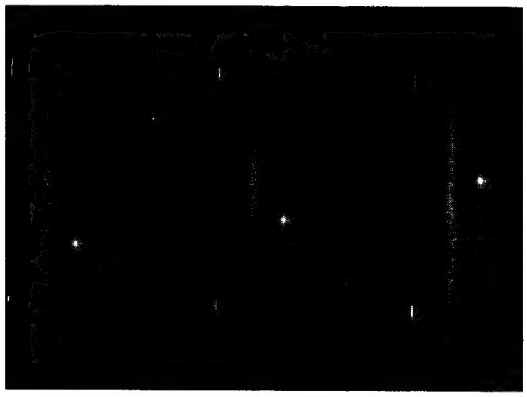

Brush land objective film

The monitor display near-vertical line may come from shadow edges apparent in the object film.

The three video lines include the raster center line and lines above and below the center by about 150 TV lines.

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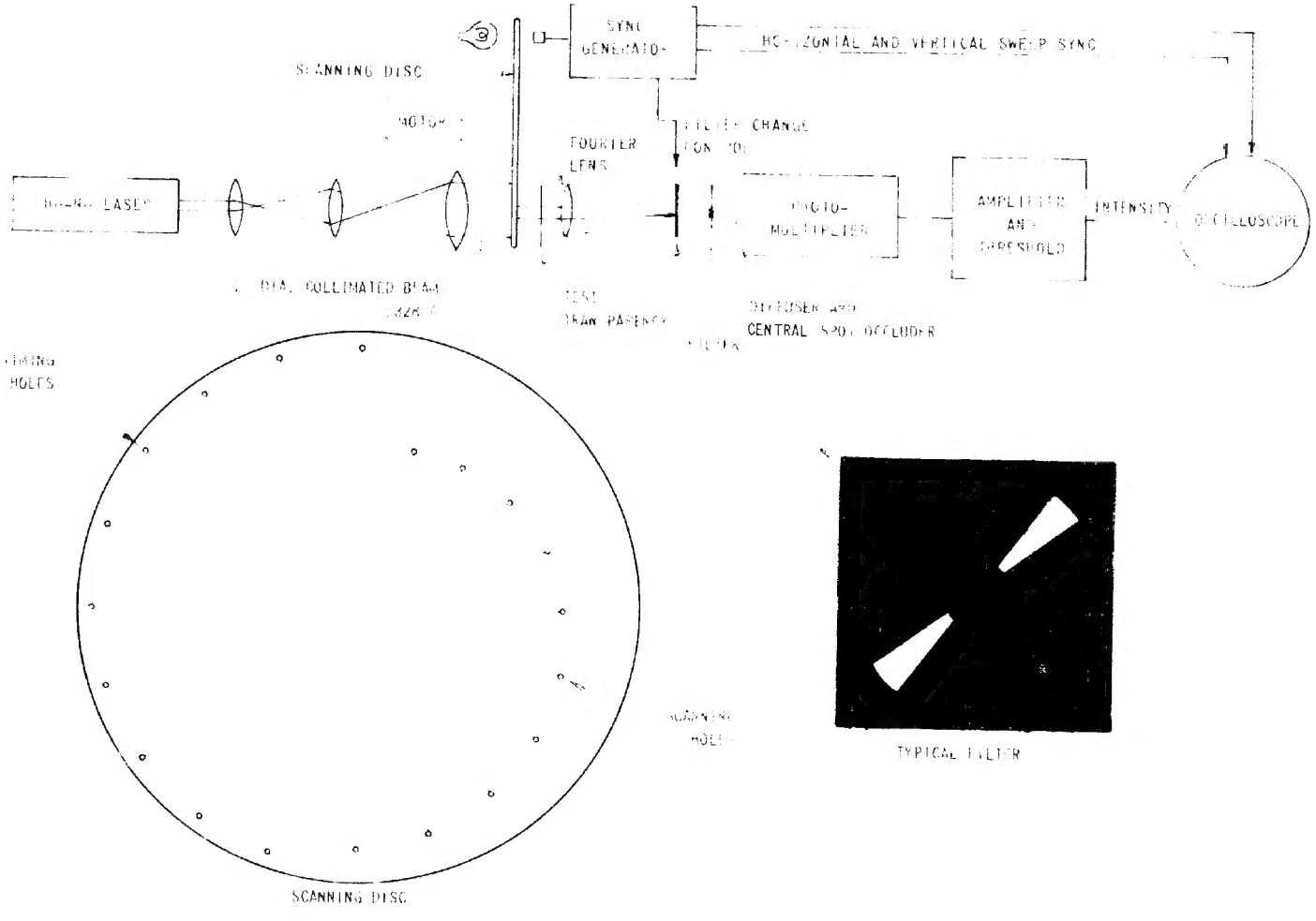

MARK III SPATIAL FILTER RECOGNITION APPARATUS EXPERIMENTAL MODEL

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